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ABSTRACT

A study involving 50 experimental and 99 control subjects (graduate education majors) was undertaken to assess the interchangeability of knowledge of correct response feedback (KRC) and answer until correct feedback (AUC) in computer-assisted instruction. P. L. Smith's model (1988) suggests that AUC in better for high-ability students. W. Dick and R. Latta (1970) found AUC to be better for high-ability students and KCR to be better for low-ability students. The study was designed to determine whether high-ability students benefit most from the deeper processing required by AUC, while low-ability students perform best with KCR, which requires less processing. Experimental subjects were randomly assigned to a AUC or KCR treatments, resulting in a 2 (treatment: AUC or KCR) by 2 (ability: low or high) factorial design. One week later, the subjects took an identical posttest that provided the final exam score for the course. Analysis of covariance revealed that low-ability students performed best with KCR, while high-ability students performed best with AUC. The interaction between ability and feedback form was significant. These findings suggest that low-ability students should be provided with KCR and high-ability students should receive AUC. The study also provides support for Smith's model of feedback by learner ability. Three data tables and three figures are included. (TJH)

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Comparative Effects of Ability and Feedback Form in Computer-assisted Instruction

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Abstract

In computer-assisted instruction, KCR and AUC feedback are used interchangeably without adequate empirical support (Dempsey and Driscoll, 1989; Kulik and Kulik, 1988; Noonan, 1984). Smith's (1988) model suggests that AUC is better for high-ability students. Dick and Latta (1970) found AUC to be better for high-ability students and KCR to be better for low-ability students. Do high-ability students benefit most from the deeper processing required by AUC? Do low-ability students perform best with KCR which requires less processing?

Subjects (Ss) included 145 graduate education majors. Ss were randomly assigned to KCR or AUC. One week later Ss took an identical item posttest which served as the final exam score for the course.

ANCOVA revealed that the low-ability students performed best with KCR feedback while the high-ability students performed best with AUC feedback. The interaction between ability and feedback form was significant at the p=.05 level, $F_{(1,47)}= 3.909$.

These findings suggests that low-ability students should be given KCR feedback and high-ability students should be given AUC feedback. This study provides support for Smith's (1988) feedback by learner ability model.

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Introduction

Tests teach (Foos & Fisher, 1988; Pressey, 1950; Rothkopf, 1966; Vallance, 1947). Like more traditional text materials, multiple-choice tests as learning experiences have been shown to improve later posttest performance not only for rote items but were even more effective for meaningful items (Fisher, Williams, & Roth, 1981).

The format of test feedback can take a variety of forms. Knowledge of response feedback (KR or KOR) indicates "right" or "wrong" with no additional comments. Knowledge of correct response feedback (KCR) typically indicates "right" or "wrong" and then adds a comment such as, "the correct response is choice B." Elaborative feedback indicates "right" or "wrong" and then adds various amounts of additional comments, diagrams, examples, and/or explanations intended to inform incorrect responses.

The comparative effectiveness for achievement gains of several forms of feedback have been established. This comparison may be summarized as:
no-feedback < KR < KCR > elaborative feedback (Smith, 1988).
Generally, KCR feedback provides the most gain for the least amount of instructional effort. Elaborative feedback forms which are thought to have promise have shown mixed results, sometimes superior to KCR and sometimes not (Merrill, 1985; Schimmel, 1983). Most studies conclude that the additional effort required to develop elaborative feedback, and the additional time required to use it are not worth the small gains that may result.

One form of immediate feedback termed answer until correct (AUC) was initially investigated some 60 years ago and has recently gained renewed research interest (Kulik & Kulik, 1988). Pressey (1926, 1927) indicated that AUC mediated by punch board was a viable way to use multiple-choice tests for self-instruction. The AUC feedback form requires the learner to continue selecting item alternatives until eventually the correct answer is selected. With AUC feedback, the learner is required to attend more fully to missed items with additional depth of processing than with other feedback forms like KR or KCR.

There have been few direct comparisons of AUC with other immediate feedback forms. Whether AUC is more or less effec-

tive in increasing achievement than no-feedback, KR, or KCR feedback is generally unknown. In fact, there are few studies extant of the effectiveness of AUC feedback mediated by microcomputer (Dempsey & Driscoll, 1989; Kulik & Kulik, 1988).

An early computer-assisted instruction (CAI) media comparison study (Dick & Latta, 1970) inadvertently compared KCR feedback to AUC feedback. A group of 64 high and low ability eighth grade students received one of two similar programmed instructional versions of the use of significant figures in mathematics. The traditional print version used constructed-response type questions and provided immediate KCR feedback. The computer version used a mixture of constructed-response and multiple-choice frames, and occasionally provided remedial branching. Every response frame in the computer version required that the learner answer until correct. An ability treatment interaction was shown for media type and ability. Programmed instruction via traditional print (KCR) was most effective and computer (AUC) was least effective for low ability students. High ability students scored equally well in both the KCR (print) and AUC (computer) conditions.

In a discussion of why the low ability students had such "startlingly poor performance" (Dick & Latta, 1970, p. 44) with the computer (AUC) condition, it was suggested that the computer (AUC) version provided too much information without opportunity to backpage or review previous frames. This overload resulted in increased errors within the lesson and ultimately lower performance. Conversely, high ability students were not overwhelmed or were better able to integrate the information in the discrimination and learning task. Similar results were produced in a study by Hansen (1974) who also noted an ability by feedback interaction with higher ability students making the best use of the additional information provided by the feedback.

The present study directly compares KCR feedback and AUC feedback in the acquisition of test content. Two questions were posed: How does AUC feedback compare to KCR feedback in achievement gain when both types of feedback are given via a computer? and Do high and low ability students perform differently with AUC and KCR feedback?

Method

The sample consisted of 50 graduate education majors enrolled in three sections of a microcomputers in education course. A control group of 99 similar students enrolled in the same course during previous semesters was utilized to establish midterm (pretest) and final exam (posttest) means and standard deviations for comparison purposes. The midterm exam served as a covariate in order to control for pre-treatment ability differ-

ences. Subjects in each experimental section were matched by pretest scores (mid term exam grades) and then randomly assigned to either the KCR or AUC treatments resulting in a 2 (treatment: AUC or KCR) by 2 (ability: low or high) factorial design.

Two acquisition tests were developed using the SuperPilot authoring language for Apple IIe computers. Each test contained the same 50 items as the posttest (final exam), but items and alternatives were arranged in a different order. One test utilized KCR feedback and the other used AUC feedback (figure 2). The KCR and AUC forms stated "correct" when the subject's response was correct. When the subject's response was incorrect, the KCR form stated, "No, the correct response is ___ (a,b,c or d)," while the AUC form stated, "No, try again." The AUC form required the subjects to continue answering until the correct answer was selected. A form of focused feedback was used with both AUC and KCR versions. Focused feedback removes distracters after each response so that the subjects see only the item and correct response. This type of feedback has been referred to as out-of-context feedback by Winston and Kulhavy (1988). Focused feedback or out-of context feedback was chosen for this study in order to reduce the processing demands on the low ability learners. If the distracters are not provided with the feedback frame, then obviously they cannot be read, resulting in less information on the frame. However, some learners and particularly high ability learners may benefit more from inclusion of distracters on the feedback frame because they have more information for comparison.

One week before the final exam, subjects used the two tests as a preview to the final exam during their regularly scheduled computer lab period. Subjects were not allowed to use texts or take notes during the preview. Both AUC and KCR forms required about 40 minutes to complete. One week later, subjects took the paper and pencil, 50 item, five-alternative multiple-choice posttest which counted as the final examination for the course (figure 1).

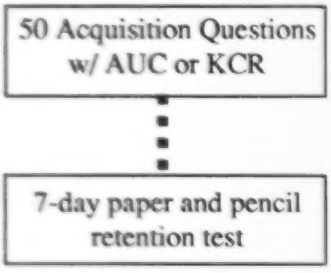

Figure 1. Diagram of Procedure

Results

The experimental group's (n=50) pretest (mid term) scores were slightly but not significantly lower than the pretest scores for the control group (n=99) suggesting group equivalence. Control and experimental group means and standard deviations are presented in Table 1.

Table 1 presents the experimental group's posttest cell means by ability and treatment. Pretest to posttest correlations for the control group obtained an r= 0.56 for 31.2% of the variance.

Analysis of variance for the posttest revealed no significant difference for either treatment or ability main effects (Table 3). The independent variables and the covariate (pretest) accounted for 30.3% of the total variance in posttest scores. The mean for the AUC treatment (44.4) was slightly lower than the mean for the KCR treatment (44.9) with F= 0.034, p=0.85. The mean for the low ability group (43.4) was only slightly lower than the mean for the high ability group (46.0) with F= 0.093, p=0.76. The interaction between treatment and ability was significant with F= 3.909, p=0.05. High ability students performed better with AUC feedback compared to low ability students with AUC feedback

Figure 2 shows the significant interaction between treatment and ability in graphic form. The figure also includes the pre-experimental control group for comparison purposes. As expected, both AUC and KCR treatments resulted in scores considerably higher than the control group scores. Note, however, that the AUC treatment maintained the average performance difference between the low and high ability group while the KCR treatment resulted in about equal performance for low and high ability subjects. For low ability subjects, the KCR treatment mean was 2.2 points higher (effect size (2.2/3.9) = 0.56) than that for the AUC treatment. For high ability subjects, the AUC treatment mean was 1.4 points higher (effect size (1.4/2.8) = 0.50) than the KCR treatment mean. This may indicate that KCR is better for low ability students while AUC is better for the higher ability students.

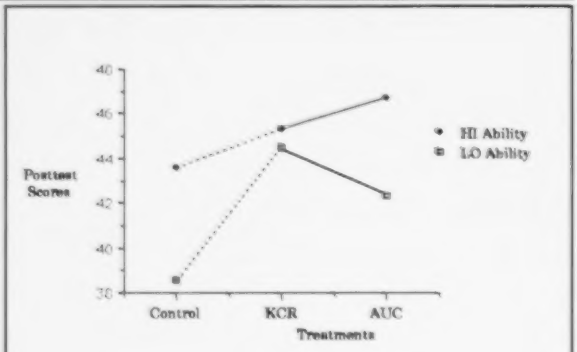

Figure 2. Posttest performance comparisons by ability and treatment for the pre-experimental control group and the experimental group.

Table 1

Pretest and Posttest Means and Standard Deviations

		PRETEST (Midterm)			POSTTEST (Final Exam)		
		CTRL	KCR	AUC	CTRL	KCR	AUC
Lo		39.0	37.5	37.0	38.6	44.5	42.3
	s.d.	2.5	3.4	3.5	4.7	3.3	4.2
Hi		45.5	44.6	44.1	43.6	45.3	46.7
	s.d.	2.0	1.9	1.8	3.3	3.1	2.2

Discussion

This study indicated that AUC feedback and KCR feedback, although each functions in a slightly different way, produced fairly equivalent performance gains overall. The significant interaction of ability by feedback type in this study replicates the results of the earlier study by Dick & Latta (1970). It also indicated that feedback format can indeed effect learning in that lower ability student tended to perform higher with knowledge of correct response (KCR), while higher ability students achieved at higher levels with answer until correct (AUC) feedback. Additional studies are needed to explore the relationships of feedback format with such constructs as, cognitive style, anxiety, amount of invested mental effort, confidence of response, locus of control, and stimulus load.

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Table 3
Analysis of Variance for Posttest (Final Exam)

SOURCE	S.S.	D.F.	M.S.	F	p
Feedback (A)	0.333	1	0.333	0.034	0.85
Ability (B)	0.908	1	0.908	0.093	0.76
A x B	38.339	1	38.339	3.909	0.05
Covariate:					
Pretest (Midterm)	65.625	1	65.625	6.692	0.01
ERROR	441.309	45	9.807		

N: 50 Multiple R: 0.550 Squared Multiple R: 0.303

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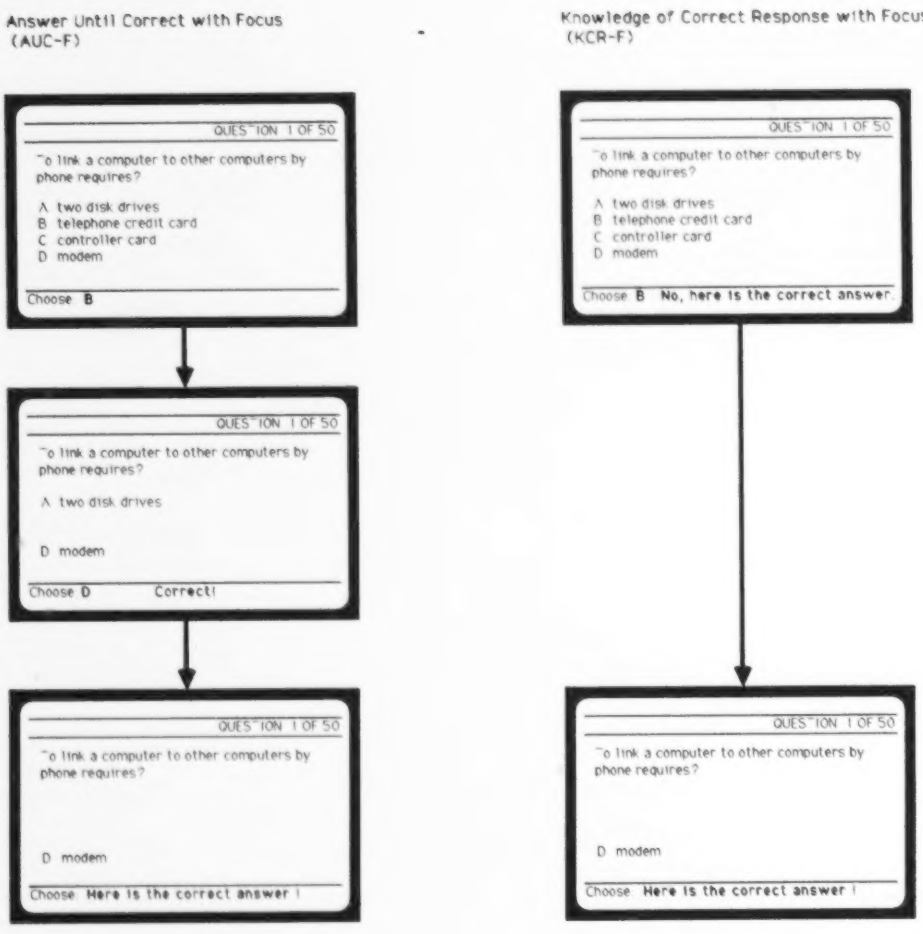
Answer Until Correct with Focus
(AUC-F)
QUESTION 1 OF 50
To link a computer to other computers by phone requires?
A two disk drives
B telephone credit card
C controller card
D modem
Choose B
QUESTION 1 OF 50
To link a computer to other computers by phone requires?
A two disk drives
D modem
Choose D Correct!
QUESTION 1 OF 50
To link a computer to other computers by phone requires?
D modem
Choose Here is the correct answer !
Knowledge of Correct Response with Focus
(KCR-F)
QUESTION 1 OF 50
To link a computer to other computers by phone requires?
A two disk drives
B telephone credit card
C controller card
D modem
Choose B No, here is the correct answer.
QUESTION 1 OF 50
To link a computer to other computers by phone requires?
D modem
Choose Here is the correct answer !

Figure 2. Slide of AUC and KCR Feedback Screens